Assessment and Management Considerations for Oral Feeding of the Premature Infant on the Neonatal Intensive Care Unit

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According to U.S. census data published by the Washington State Department of Health (2002), approximately 309,000 low birth weight infants, defined as < 2500 grams, were born in 2000, representing 7.6% of total U.S. births. Currently, most infants born at 24 weeks gestational age or greater survive in developed countries as a result of life saving medical advances in neonatal care that have occurred over the last few decades. New technology, medications, and interventions within the neonatal intensive care units (NICU) have resulted in increased survival rates. Because the overall rate of disability has remained fairly stable, there are also now more children living with disability. Disabilities may occur in the NICU population due to complications associated with preterm birth, such as bronchopulmonary dysplasia (BPD), asphyxia, and intraventricular hemorrhage, which likely affect neurological maturation as well as development of feeding and respiratory control. As a group, low birth weight infants have a higher rate of suboptimal growth, adverse health conditions, and neurodevelopmental problems than children born at term. Predictably, neurological, neurodevelopmental, neurosensory, and functional morbidities increase with decreasing birth weight. The preterm infant is distinctly disadvantaged compared to the term infant with respect to feeding skill development, as many factors preclude the preterm infant's feeding efficiency: gestational age; muscle tone; physiological instability; behavioral state; minimal energy reserve; immature respiratory, gastrointestinal and nervous systems; as well as overall medical status (Premji, McNeil, & Scotland, 2004). Anderson (2002) identified the following as factors that may lead to nutrient deficiencies and/or toxicities in preterm infants:

1. An early birth limits the infant's nutrient stores
2. Rapid growth quickly depletes the infant's small nutrient stores and creates the need for nutrient intakes to meet the demands of growth
3. Illness is frequently present which alters nutrient demands, feeding tolerance, and choice of feeding methodology
4. Physiologic immaturity, specifically within the gastrointestinal tract, interferes with advancement and tolerance of enteral nutrition.

Because of these factors, premature infants' nutritional needs are greater and more complex than the healthy term infant (Anderson, 2002). Given the complexity of the NICU population, the decisions, challenges, and responsibility involved in the introduction and management of oral feedings for preterm infants do not belong to one profession. Transitioning a sick or preterm infant to safe oral feeding requires collaborative efforts from caregivers and a broad range of health-care professionals, including nurses, dietitians, speech-language pathologists, occupational therapists, physical therapists, lactation consultants, and physicians.

Developmental Considerations

Oral feeding trials cannot be attempted until the preterm infant develops the skills necessary to begin oral feedings and overall health status stabilizes sufficiently, regardless of postnatal age (Thoyre, Shaker, & Pridham, 2005). Infants commonly swallow as many as 60 times per minute, making it important for respiration to be exquisitely coordinated with swallowing. Preterm infants often have difficulty coordinating the potentially conflicting demands of respiration with suckle feeding. In a comparison of respiration and swallowing between preterm infants and term infants, Gewolb and Vice (2006b) reported that postmenstrual age (PMA), defined as the time elapsed between the first day of the last menstrual period and birth (gestational age) plus the time elapsed after birth (chronological age), correlated better with developmental suck and swallow measures than did the postnatal age. Initial feeding efforts by neonates conducted at 32 to 34 weeks PMA were characterized by periods of apneic suckle feeding runs (i.e., runs of ≥ 3 swallows without interposed breaths) alternating with tidal respirations. With further development, the neonates' respirations became interposed into spaces partitioned by swallows. Finally, breathing efforts were integrated into an overall suck-swallow-breather rhythm. Therefore, Gewolb and Vice found that the percentage of apneic swallows decreased with increasing PMA in pre-term infants. Moreover, they cautioned against beginning oral feedings too soon, as coordinated sucking and swallowing reflexes are not fully developed until approximately 34 weeks of gestation. At 32-weeks of gestation, esophageal motility is also discoordinated and the anti-reflux mechanisms of a properly function-

ing lower esophageal sphincter are not yet fully developed (Premji et al. 2004). Hawdon, Beauregard, Slattery and Kennedy (2000) studied two groups of preterm neonates: normal feeding and disorganized/dysfunctional feeding based on clinical swallowing observations. Although median gestational age did not vary between the two groups (36 weeks PMA), there were no infants of < 30 weeks gestation in the normal feeding group, while 50% of infants in the disorganized or dysfunctional feeder group were < 30 weeks gestation. Babies in the disorganized or dysfunctional group had a longer median duration of ventilatory support; duration of both parenteral feeds and gavage feeds was significantly longer; introduction to oral feeding was later; and the time to establish full oral feeds was longer than for the normal feeding babies.

Gestational age is not the only consideration before beginning oral feedings, as special attention should be given to heart and lung function, gastrointestinal health, as well as developmental status before beginning oral feeding (Arvedson, 2000). Wolf and Glass (1992) emphasized the need for thorough assessment of the infant's underlying medical status prior to initiating oral feedings, as the infant's ability to suck and swallow may be influenced by the combined impact of impaired respiratory function, inadequate cardiac support or endurance, and abnormal sensory systems as a result of prematurity, medical conditions, and medical interventions. For instance, Gewolb and Vice (2006a) studied individual rhythms of suck, swallow, and respiration of preterm infants with and without BPD. BPD is a condition characterized by chronic lung disease of varying severity that frequently occurs in preterm infants with prior respiratory distress syndrome who have been treated with prolonged oxygen and ventilator therapy. Gewolb and Vice (2006a) reported that the preterm infants with BPD evaluated at 32-40 weeks PMA exhibited a significantly higher percentage of apneic swallows than similarly aged preterm infants without BPD. Infants with PBD had difficulty achieving coordinated suckle feeding, which resulted in decreased nutrient intake, increased caloric expenditure, and reduced rates of growth. The authors speculated that an infant with BPD might not be able to sufficiently decrease his or her already tachypneic respiratory rate (respiratory rate > 60 breaths/minute) to coordinate suck-swallow rhythm without a compromise in oxygen saturation, resulting in the disruption of the suck-swallow rhythm much more frequently than the baby without pulmonary disease. Rudolph and Link (2002) reported that during vigorous sucking and swallowing, as occurs early in a feeding session, there is often a reduction in minute ventilations with mild hypoxia occurring even with normal term babies. However, patients with compromised respiratory or cardiac function at baseline often have serious difficulties with hypoxia during feeding. Therefore, the potential impact of co-existing medical complications and developmental expectations must be considered in each infant when evaluating the potential for successful introduction of oral feedings.

Clinical Swallowing Observations

In the past, the primary measure of a neonate's feeding ability was how long he or she took to complete a feeding. Time of feeding alone is no longer judged to be a reasonable measure of feeding success for a neonate. Rather, quality of feeding is now emphasized in order to highlight aspects of feeding that research has shown to be critical: Infant behaviors, stress cues, and attempted interventions are now recommended to be documented by caregivers of the NICU patient (Ancona, Shaker, Puhek, & Garland, 1998). The infant's stress cues are typically separated into three categories: state control/endurance, breathing/physiologic, and coordination/swallowing to completely capture the complexity of variables impacting each feeding. Fluctuations in an infant's behavioral state may mediate feeding success and should be carefully documented for each feeding. Premji et al. (2004) warned that signs of physiological distress displayed by premature infants may be subtle (e.g., hiccups, facial grimaces) or more obvious (e.g., changes in heart and respiratory rate). Therefore, all NICU personnel should be carefully trained in feeding observational techniques. NICU professionals are encouraged to chart more descriptive qualitative information, in addition to the more traditional measures of time per feeding and volume of intake, to assist the team with the decision process regarding plan of care and oral feeding advancements.

To help NICU teams with oral feeding transitions and program planning, the Regional Neonatal Oral Feeding Protocol (RNOFP) was proposed by Premji et al. (2004) to facilitate systematic transitions to oral feedings and provide support for evidence-based decision making. Similarly, Thoyre et al. (2005) proposed a developmentally supportive approach for analysis of an infant's readiness and tolerance of oral feeding using their Early Feeding Skills (EFS) Assessment protocol. They described the EFS as a checklist designed to profile the infant's developmental stage regarding specific feeding skills, such as the ability to remain engaged in feeding, organize oral motor functioning, and coordinate swallowing with breathing while maintaining physiologic stability. Whether a NICU team uses the RNOFP, the EFS, or their own hospital specific protocol, watchful vigilance, multidiscipline collaboration, and

careful documentation of an infant's progress are imperative during the introduction of oral feedings.

The quality of the feeding interaction is more important than the quantity of liquid consumed orally by the infant, and every feeding assessment must include an understanding of the infant's medical condition, assessment of maturity level, and evaluation of feeding performance. A thorough knowledge base of normal development is an essential prerequisite for all persons who evaluate children with feeding and swallowing problems, given that oral feeding problems may occur at any stage of oral feeding development (Arvedson, 2000). Arvedson emphasized that the clinical evaluation should be conducted with primary caregiver involvement whenever possible as the starting point for consideration of oral feeding recommendations, determining the need for additional test procedures, and providing the basis for management decisions. The importance of observing the caregiver during a feeding is paramount in the RNOFP model of feeding assessment (Premji et al., 2004). Premji and colleagues stated that the success of the oral feeding is dependent on not only the infant's ability to feed, but also the caregivers' ability to provide an environment that optimizes feeding performance.

Even a careful clinical feeding assessment conducted by a skilled clinical observer may be insufficient to determine the presence/absence of aspiration and subsequent effectiveness of different management options. Laryngopharyngeal sensory deficits due to a neurologic disorder or from chronic gastroesophageal reflux may predispose infants to problems with coordination of sucking and swallowing, increase aspiration risk, and decrease protective cough reflexes (Rudolph & Link, 2002). Laryngopharyngeal sensory testing during a fiberoptic endoscopic evaluation of swallowing (FEES) has been suggested as a useful adjunct to the clinical swallowing evaluation to assess secretion management, measure the sensory capacity of the larynx, and assess the airway protective capacity of the larynx (Link, Willging, Miller, Cotton, & Rudolph, 2000). Research has indicated that the cough reflex is absent in 75% of premature infants and in 50% of newborns (Loughlin & Lefton-Greif, 1994), and silent aspiration without accompanying cough or obvious signs of distress has been documented on videofluoroscopy for 94% of those children exhibiting aspiration (Arvedson, Rogers, Buck, Smart, & Msall, 1994). Therefore, many facilities use the videofluoroscopic swallowing study (VFSS) with the NICU population to supplement a clinical swallowing/feeding observation and/or FEES if swallowing problems are suspected (Dusick, 2003).

VFSS Considerations

The goal of a VFSS is to obtain more specific information about the integrity of the infant's swallow as well as to help clarify aspects of a treatment plan. Abnormalities in swallowing performance can be delineated to identify causes and symptoms of dysphagia, make decisions regarding the safety of oral feedings, and provide recommendations regarding dysphagia treatment and management (Pinder & Faherty, 1999).

In contrast to a barium swallow study or upper GI study, the infant is positioned in an upright "feeding position" during a VFSS in an attempt to simulate his or her habitual feeding position. This positioning is particularly valuable for infants with dysphagia, because their swallowing function has been found to worsen without postural support for feeding in the supine position as for a barium swallow study (Dusick, 2003). The VFSS procedure should begin with the feeding method that has proven to be most successful for the infant on the basis of a previously conducted clinical feeding observation. During a VFSS, a normal swallow (i.e., no deficits) must be differentiated from a functional swallow (i.e., minor differences, but basically a safe feeder) and a dysfunctional swallow (i.e., significant differences that require major modifications to enhance swallowing safety and in some instances require nonoral feeding restrictions; Arvedson & Lefton-Greif, 1998).

The clinician conducting the VFSS with a NICU patient must have an in-depth understanding of developmental expectations for normal feeding behavior in the neonate. For instance, the location marker for determining delay in swallow reflex initiation for infants and young children is different from that of older children and adults because infants collect the bolus in the valleculae before triggering the pharyngeal swallow (Arvedson & Lefton-Greif, 1998). Moreover, epiglottal undercoating (i.e., contrast noted on the inferior surface of the epiglottis) during the first one or two swallows in a nipple feeding sequence appears to be a variant within the normal range in the infant. However, an increase in the frequency of epiglottal undercoating as a function of time is more likely to be associated with an increased risk of aspiration as the child fatigues. The risk of aspiration must be estimated on the basis of the frequency and number of penetration episodes in relation to the patient's overall history and quantity of material penetrated. Constant penetration regardless of viscosity of liquid presented and/or feeding method may be an indication of an undiscovered structural deviance such as laryngeal cleft, which would require additional endoscopic evaluation in order to rule out structural abnormality. Aspiration in the infant typically appears as material coating on the posterior tracheal wall, which differs from older chil-

dren and adults, as they usually exhibit aspirate material coating visible on the anterior tracheal wall. Arvedson and Lefton-Greif attributed this marked difference to changes in the laryngopharyngeal anatomy with maturation.

If difficulties are noted with the patient's habitual feeding pattern, modifications can be attempted during the VFSS to address the specific difficulties observed, as the clinician systematically judges the effectiveness of any potential change to the feeding situation in an effort to minimize the risk of aspiration (Pinder & Faherty, 1999). The definitive finding of aspiration, if modifications and compensatory strategies were unsuccessful to eliminate the aspiration, should lead to recommendations to avoid a particular consistency or feeding method. The timing of aspiration, whether it occurs before, during, or after the swallow, determines what modifications should be attempted during the VFSS procedure (Arvedson & Lefton-Greif, 1998; Pinder & Faherty).

Multiple strategies can be utilized in an effort to increase an infant's feeding performance. Arvedson (2000) recommended that following the typical feeding observation, changes can be made in positioning, texture, size of bolus, timing between bolus presentations, and utensils for improvement of swallowing efficiency. Children with neurological impairments most commonly demonstrate silent aspiration before or during swallows of thin liquid (Arvedson & Lefton-Greif, 1998; Pinder & Faherty, 1999; Rudolph & Link, 2002). Therefore, modifying viscosity with use of a thickened liquid may be a modification attempted during the VFSS.

Rudolph and Link (2002) discussed the difference that nipple selection provides for a preterm infant. They described the preterm infant as typically generating lower suction pressures, with smaller amounts of liquid being expressed per suck. Preterm infants and those with neurological disorders may experience more difficulty adjusting to different nipple types than term infants. Rudolph and Link suggested that in some preterm infants the slow flow rate nipples require increased energy to suck, which may be detrimental; while in others, the rapid delivery of milk from the nipple may necessitate more frequent swallowing, which can interfere with ventilation. Schrank, Al-Sayed, Beahm, and Thach (1998) found that rapid flowing formula from the nipple caused equally rapid increases in suck and swallow frequency in term and preterm infants resulting in an increased ingestion rate. Although increased loss of liquid anteriorly out of the mouth with drooling occurred in both groups, drooling was more prominent in the preterm infants with high flow rate. Preterm infants' peak sucking and swallowing rates were found to be substantially less than those of term infants, suggesting that preterm babies had a "maximum achievable rate" regardless of flow rate. Schrank et al. speculated that the relative inability to suck and swallow rapidly may be major contributors to the preterm infants' well known slow rate of ingestion. Shaker (1990) suggested use of a firmer nipple with neonates, as it permits a more controlled, manageable liquid flow rate and aids with the infant achieving a more cupped tongue shape and stronger latch on to the nipple. The impact of these subtle differences can be systematically assessed during a VFSS procedure to ensure that the most efficient feeding method is recommended for the child.

The effectiveness of introducing external pacing by the feeder can also be assessed as a compensation for those infants with rapid respiratory rate and poor suck-swallow-breathe rhythm by having the feeder tip the bottle to pause liquid flow briefly to allow a swallow without more milk coming into the mouth (Premji, Paes, Jacobson, & Chessell, 2002). Fatigue-related dysphagia due to limited endurance and/or poor suck-swallow breathe coordination must also be ruled out with the NICU population, because infant swallowing safety may deteriorate with increased work of feeding. Therefore, the infant should be observed periodically throughout a feeding even if the performance looks appropriate at first. If the infant demonstrates strong oral feeding skills at the onset and then becomes unsafe as the feeding progresses, limiting the volume of oral presentation per feeding to provide small volume "taste trial" opportunities can mean the difference between a completely non-oral feeding restriction and allowing the child to have some developmentally critical oral experience (Pinder & Faherty, 1999; Wolf & Glass, 1992).

Some (Abraham, 2005) have described a "trach effect" in infants who are status post tracheostomy. Infants with tracheotomy tubes demonstrate a higher incidence of swallowing difficulties and a variety of differences in swallowing physiology during instrumental evaluation. Frequent changes in swallow physiology that have been observed in this population include slowing of laryngeal vestibule closure, reduced laryngeal excursion, and airway contamination resulting from these deficits (Abraham). Tracheostomy in infants and young children causes significant adverse changes to secretions, secretion management, and airway protection responses. Abraham reported that, aside from decannulation, the most effective treatment for these changes is placement of one-way speaking valve. After a child is tolerating a speaking valve and demonstrating subsequent improvements in secretion management at the level of the oral cavity, larynx, and/or trachea, the patient's swal-

low function can be assessed via VFSS in order to assess the impact of these factors on the patient's swallowing safety.

Management of Dysphagia

The goals of dysphagia management are to foster safe and pleasant feeding and support normal growth in the infant (Dusick, 2003). Recommendations from the VFSS, ongoing clinical feeding observations regarding effectiveness of the recommended feeding program, and clear interdisciplinary communication will foster optimum feeding skill development in the neonate. A developmentally supportive approach to nipple feeding that promotes full nipple feeding earlier, while facilitating endurance, intake volume, and safety has been introduced to NICUs (Ancona et al., 1998). Dusick stated that management of dysphagia requires an individualized approach for each infant that can be divided into six broad areas of intervention:

- Positioning
- Adaptation of foods and/or feeding equipment
- Oromotor therapy
- Feeding therapy
- Nutritional support
- Management of associated disorders

Medical management of problems associated with dysphagia, such as gastroesophageal reflux, chronic lung disease, and constipation, is also essential to a successful feeding plan (Dusick). Maintenance of the airway and nutrition must always remain the highest priority, and oral sensorimotor practice cannot jeopardize nutrition and pulmonary status (Arvedson, 2000; Arvedson & Lefton-Greif, 1998; Arvedson et al., 1994).

The child's response, or lack thereof, to aspiration is a critical factor in management considerations. As stated above, silent aspiration is prevalent in the pediatric population. In a discussion of team decision-making process regarding oral feeding in the presence of dysphagia, Rudolph and Link (2002) stated that decisions regarding whether to allow oral feeding depend on balancing the potential risks for aspiration and subsequent chronic lung disease with the emotional rewards and convenience of oral feeding. It is a team decision catered to each individual infant's medical situation to determine the amount of aspiration that is deemed acceptable or "safe" based on the patient's underlying medical situation, ability to clear the airway with cough, and ciliary flow. After a comprehensive literature review regarding silent aspiration, Ramsey, Smithard, and Kalra (2005) concluded that the consequence of chronic silent aspiration remains unknown and the uncertainty in management of silently aspirating patients can be resolved only if its etiology and consequences are better understood.

One advantage of the VFSS is the ability to involve the parents in the study and educate them on the swallowing process, especially if the occurrence of aspiration, particularly silent aspiration, is present during the study. The value of the VFSS as a parent education tool cannot be understated, as parental understanding of swallowing dysfunction and the importance of customized feeding protocols helps to increase compliance with feeding management recommendations (Arvedson & Lefton-Greif, 1998; Pinder & Faherty, 1999).

Predicting the Future for NICU Graduates

As previously stated, disabilities persist in the NICU graduate secondary to the neurological, neurodevelopmental, neurosensory, and functional morbidities prevalent in the sick or low-birth weight infant. Burklow, Phelps, Schultz, McConnell and Rudolph (1998) conducted a retrospective analysis of 103 pediatric feeding team evaluations and concluded that systems using a dichotomy of organic/non-organic classification were insufficient to adequately discriminate the differences in children with feeding disorders, as the majority of pediatric patients with feeding disorders demonstrated a combination of organic and non-organic problems. Therefore, the authors proposed using a multi-dimensional classification system that described children's feeding issues with respect to structural abnormalities, neurological conditions (including developmental delay), behavioral issues, cardiac problems, and metabolic dysfunction. They found that 38% of all infants and children referred for interdisciplinary evaluation of complex feeding issues had been born prematurely (range 24 to 36 weeks), with Structural+ Neurological+ Behavioral as the most commonly occurring combinational code (30%), followed closely by Neuro-logical+Behavioral at 27%. Burklow et al. hypothesized that prematurity, combined with congenital malformations or neurologic disorders, may disrupt the typical development of eating in infancy and provide opportunities for a child and his/her caregivers to acquire maladaptive behavioral patterns.

Hawdon et al. (2000) documented a 40% incidence of immature or abnormal feeding patterns in a random sample of NICU admissions assessed at 36 to 40 PMA. Upon re-evaluation at 6 and 12 months corrected age, those infants who had previously exhibited abnormal feeding patterns were exhibiting significantly more difficulties transitioning onto solid foods and/or enjoying mealtimes, in comparison to the neonates who had normal initial feeding assessments in early infancy. Hawdon and colleagues concluded that long-term

feeding problems are a serious and often unrecognized potential consequence of neonatal conditions.

Dodrill et al. (2004) assessed feeding skill development of toddlers between the ages of 11 and 17 months who had been born preterm (i.e., 32 to 37 weeks gestational age) without any severe medical comorbidities. They reported that the otherwise healthy preterm infants who required supplemental nasogastric (NG) tube feedings for >3 weeks before transitioning onto full oral feedings displayed significantly more facial defensiveness and significant delays across more of aspects of their feeding development than those preterm infants who received <2 weeks NG tube feedings.

In contrast, there are also incidences of dysphagia experienced in the neonatal period that resolve due to resolution of the original catalyst for the dysphagia. For instance, Arvedson and Lefton-Greif (1998) stated that preterm infants who are hypotonic with a weak suck usually have a positive prognosis for long-range functional oral feeding as their central nervous system matures. Similarly, Pereira, Webb, Blakely, Cox, and Lally (2006) examined 100 premature infants undergoing patent ductus arteriosis (PDA) ligation via endoscopy. They found 7 of the 100 children exhibited post-operative vocal fold paralysis, with two of the seven children also exhibiting sufficient stridor and dysphagia that required NG tube feedings post-operatively. At their 9-month follow-up examination, five of the seven infants with previously reported paralysis had satisfactory compensation by the normal vocal fold for consistent airway closure, and all feeding difficulties had resolved in the original two children with dysphagia. As soon as the primary medical conditions had normalized, all signs or symptoms of dysphagia resolved.

While the incidence of survival rises with medical advancement, it is my hope that the long-term prognosis for quality feeding skill development in our neonatal intensive care graduates will also improve due to the combined impact of technology advancement, systematic diagnosis, and developmentally sensitive management of the infant's dysphagia resulting in a decrease in long-term feeding issues.

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Continuing Education Questions

1. What factor has been found to correlate best with measures of suck and swallowing development in the premature infant?

a. Maternal age at time of birth

b. Quality of prenatal care

c. Postmenstrual age of infant

d. Post-natal age of infant

2. The current trend in clinical assessment of a baby's feeding performance in the NICU stresses the importance of

a. the average length of time it takes to feed the baby.

b. the quantity of food consumed by the baby.

c. the baby's rate of weight gain over a two day period.

d. the overall quality of the feeding experience.

3. Unlike adults, aspiration in the infant appears

a. as material coating the posterior tracheal wall.

b. as material coating the anterior tracheal wall.

c. only in the condition of a structural abnormality such as laryngeal cleft.

d. whenever penetration occurs.

4. Online modifications are attempted during a VFSS with an infant from the NICU whenever

a. the infant experiences apnea after the feeding.

b. difficulties are noted with the patient's habitual feeding pattern in an effort to minimize aspiration or aspiration risk.

c. the clinician has sufficient time available to try different nipples.

d. the infant has a tracheostomy.

5. Appropriate management of an infant's dysphagia requires

a. individualized patient-specific multidisciplinary decision-making on the basis of thorough observations and concise communication.

b. a consistent decision making protocol that is based on the infant's gestational age, regardless of medical diagnosis.

c. standardization and/or feeding protocols regarding the infant's positioning and specific feeding equipment to assure that all NICU patients are fed in the same manner.

d. a videofluoroscopic swallowing study to be performed on all NICU patients prior to introduction of oral feedings as standard protocol.